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House price changes, house expenditures and saving

Including maintenance and home improvements in a life cycle model

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Previous studies have found evidence for the effect of unexpected house price changes on consumption and saving as predicted by the life cycle model. Furthermore, strong evidence for an effect on house expenditures has been found. Households increase house expenditures when house prices increase. In this study a life cycle model is developed with house expenditures that connects these two topics. The model predicts that the effect of house price changes on consumption and saving increases with the price level. This predictions are empirically tested using data from the Dutch national bank (DNB) Household Survey (DHS). No evidence in favour of the effect on house expenditures is found using limited data. Evidence in favour of the effect on saving is found.

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1 Introduction

For most households, housing is their largest expense while the house itself is often their most valuable asset. Fluctuations in house prices give rise to the largest share of household wealth volatility (ING, 2016). This characteristic of home ownership is a result of the financing of real estate through mortgages. Relatively small changes in house prices have large effects on the net wealth of households. Life cycle models of consumption and saving suggest that changes in net wealth affect the lifetime income constraint and the liquidity constraint (Dolde & Tobin, 1971). Fluctuations in net wealth have an immediate collateral effect on household saving and consumption when households experience liquidity constraints. The wealth effect on lifetime income depends on whether the household expects that this change in net wealth is permanent or temporary (Dolde & Tobin, 1971). Houses are a major component of net wealth, and therefore, households are expected to adjust consumption and saving following changes in house prices. This has been addressed in a number of studies, and evidence in favour of the collateral and wealth effect has been found (Bhatia, 1987; Skinner, 1996; Engelhardt, 1996; Campbell & Cocco, 2007). Additionally, studies for the Netherlands find similar evidence (Rouwendal & Alessie, 2002; Suari Andreu, 2014). In this thesis, the life cycle model with housing as developed by Suari Andreu (2014) is extended to include house expenditures such as maintenance and home improvements. The responses to unexpected house price shocks that this model predicts are empirically tested using data from the DNB Household Survey. Maintenance and improvements allow households to invest in their depreciating stock of housing in order to maximize utility (Montgomery, 1992). Besides increasing utility, these expenditures increase house value and a share of the costs is returned when the house is sold. These returns and therefore the relative prices of these expenditures depend on the expected house price level when the house is sold. This affects demand for maintenance and improvements directly (Gyourko & Saiz, 2004).

The contribution of this thesis to the literature is that it connects the two previously separated subjects of consumption and saving, and house expenditures and how households adjust these following house price fluctuations.

2 Home-ownership and consumption

In this section I will discuss the developments in the life cycle model with housing equity and the insights it has provided in consumption and saving behaviour. The life cycle model, as introduced by Modigliani and Brumberg (1954), states that at any point in time, a household's consumption is not explained by the current income, but by the total expected lifetime income and the position in the life cycle. Wealth acts as a cushion against variations in income to smooth consumption. Consumption is planned by maximizing a utility function with respect to the budget constraint (Modigliani & Brumberg, 1954). Dolde and Tobin (1971) develop a model for the impact of monetary policy on consumption in a life cycle model framework in which capital gains increase lifetime income and ease liquidity constraints. They concluded that: "The model generates aggregates which are realistic and plausible in magnitude and in their simulated time paths" (Dolde & Tobin, 1971). Artle and Varaya (1978) argue that the purchase of a house is typically the largest investment a household will make in their life and as an important component of wealth it is likely to play a considerable role in consumption planning. Surprisingly, home-ownership and capital gains are often omitted in consumption and saving studies. Artle and Varaya (1978) lay the foundation for future studies by developing a life cycle model with residential housing. Peek (1983) introduces capital gains in an empirical analysis of saving behaviour. Using aggregated data on household sector net capital gains in the United States, Peek (1983) is able to substantially improve the understanding of fluctuations in saving. Strong evidence is found that household capital gains negatively affect savings, although the magnitude of the effect is smaller than expected (Peek, 1983). Bhatia (1987) argues that consumers assess capital gains using their own expectations instead of benchmarks. Weak evidence in favour of the effect is found using United States housing census data (Bhatia, 1987).

A wave of micro studies with inconsistent results follows and contradictory evidence for behaviour as predicted by the life cycle model is found. Using the Retirement History Survey (RHS) Venti and Wise (1990) find that elderly in the United States are reluctant to decrease housing equity. In contrast to the predictions of the life cycle model, households are unwilling to consume out of housing wealth (Venti & Wise, 1990). Levin (1998) is able to consider the effects of house price changes on household consumption as recorded in the RHS. Using a basket of ten consumption goods, no evidence for an effect of house price changes on consumption is found. Households seem to consider high psychological transaction costs for consuming out of non-liquid wealth (Levin, 1998). In an attempt to tackle these unexpected results Skinner (1996) considers two groups of American households with age lower and higher than 45 from the Panel Study of Income Dynamics (PSID). The respondents of the RHS are between 57 and 62 years of age. The results of Skinner (1996) are in line with the life cycle model, the wealth effect is found for the younger households where it is absent for older households. This can be explained by the concept of precautionary savings. Older households have no incentive to consume out of housing wealth in the absence of a large negative income shock (Skinner, 1996). Hoynes and McFadden (1994) find conflicting evidence of an increase in saving following house price appreciations using the same PSID dataset. Engelhardt (1996) analyses these contradictory results and is able to explain the differences in their approach. Skinner (1996) uses a measure of real saving without passive capital gains to assets whereas Hoynes and McFadden (1994) do not exclude passive capital gains to assets. These passive capital gains to assets are fuelled by increases in economic activity which are strongly correlated with house price increases. Furthermore, Engelhardt (1996) argues against the use of the house price index by Hoynes and McFadden (1994). It is probably not representative for all homes in the market. Skinner (1996) uses self-reported home values from the survey and is not affected by the low quality of the house price index. Lastly, Engelhardt (1996) argues that the inclusion of renters in the sample of Hoynes and McFadden (1994) disrupts the results. Renting households could be saving for a house and this would be positively correlated to housing prices. In the accompanying empirical analysis Engelhardt (1996) finds results in line with Skinner (1996) in favour of the life cycle model with housing. Additionally, evidence for an asymmetry in the saving response to housing capital gains is found. Households experiencing real losses increase their saving where households experiencing capital gains do not seem to reduce their saving. Engelhardt (1996) finds no evidence that this asymmetry is related to the age of the household.

Rouwendal and Alessie (2002) study this effect in the Netherlands from a microeconomic point of view using the Socio-Economic panel (SEP) data. Multiple interesting findings are reported. The first finding is that Dutch home-owners are well informed of house prices. Their perception of house prices is in line with market prices. Second, increasing household equity increases demand for second mortgages. Second mortgages are mainly seen as an important channel of monetizing increased housing value and this finding supports the idea of increased consumption following increased house prices. The third and main result of Rouwendal and Alessie (2002) is that house price changes do seem to affect saving negatively. In contrast to Engelhardt (1996) and others, no evidence for asymmetry is found.

Campbell and Coco (2007) find similar evidence in favour of the life cycle model with housing for home-owners in the United Kingdom. Striking is the result that the effect of house prices on consumption increases with age. While this is in line with the life cycle model, it contradicts earlier findings. This contradicts with Skinner (1996) who finds that older households are unwilling to consume out of housing wealth. Attanasio, Blow, Hamilton and Leicester (2009) fail to find evidence for this age effect using the same data as Campbell and Coco (2007).

Cristini and Sevilla (2014) compare these two opposite results and find that the crucial element driving the differences is the specification of the model. Campbell and Coco (2007) estimate a consumption Euler equation while Attanasio et al (2009) use a reduced form consumption function. As both these specifications have their shortcomings, it is impossible to judge which is the better approximation without further research (Cristini & Sevilla, 2014).

Suari Andreu (2014) uses data from the Dutch national bank Household Survey(DHS) to study the relation for Dutch households. The DHS includes a self-reported measure of saving that allows for precise analyses with respect to active saving behaviour. Moreover, house prices in the period studied (from 2003 to 2013) have experienced a boom and bust that could provide valuable information. Suari Andreu (2014) finds evidence in favour of the asymmetric wealth effect in response to observed, house price changes. Furthermore, this effect seems to be increasing with age as found by Campbell and Coco (2007). Since 2003, the DHS also includes an expectation of house market prices. Suari Andreu (2014) includes an an analysis with respect to the unexpected price change that is possible using the expected price changes. Evidence is found that households respond to unexpected changes in market prices. No evidence for this behaviour with respect to self reported house price levels is found.

This great variety of results with respect to asymmetry and age is an obstacle in declaring a general relation between house prices, saving and consumption. Results are influenced by the choice for model specification while the effect itself may be influenced by time trends and cultural differences.

3 House expenditures

Little research has been done in the subject of house expenditures. While a large number of studies focus on the housing market, there has been little attention for the maintenance, remodelling and improvement market. This is partially the result of the limited availability of accurate data. The few studies in this subject have focused on the dual role of owner-occupants as consumers and investors (Mendelsohn, 1977). Using United States census data, Mendelsohn (1977) is the first to show empirically that households with higher income, higher housing value or both spend more on maintenance and improvements. Although Mendelsohn (1977) uses a life cycle framework for his analysis, there is no attention for market prices. Montgomery (1992) develops a model with a house price index and its growth, a building cost index for home improvements and moving costs. The following empirical analysis shows that house expenditures - with and without maintenance - are positively correlated with the price level as expected. Moreover, including maintenance in house expenditures does not spawn substantially different results but it does improve explanatory power (Montgomery, 1992). Montgomery (1992) argues that defining maintenance and improvements as two different types of expenditures is arbitrary. Households treat these two types of house expenditures approximately similar. Gyourko and Saiz (2004) focus primarily on the investment side of house expenditures. They argue that renovation and construction costs are similar and that households should stop reinvesting in their housing stock when the market value of the house falls below construction costs. Data from the American Housing Survey (AHS) is used to empirically assess this reasoning. They find that home improvement expenditures fall significantly, but are not eliminated, when the costs exceed construction value. This indicates that households consider the investment aspect of home improvements but also engage in improvement projects when these are not profitable (Gyourko & Saiz, 2004). Gyourko and Tracy (2006) show empirically that households adjust maintenance expenditures following an income shock likewise as adjustments in durable consumption. Households substantially lower house expenditures after a negative income shock (Gyourko & Tracy, 2006). Choi, Hong and Scheinkman (2014) develop a speculation-based theory of home improvements, they expect that home-owners are optimistic enough about future house prices that they engage excessively in improvement and remodelling projects in periods of increasing prices. Choi, Hong and Scheinkman (2014) observe that recoup values of home improvements rise slightly with price level increases. Contrary to popular belief in periods of large price increases, home improvements are hardly ever profitable. Their empirical analysis uses estate agent data from a large number of cities in the United States. Households seem to increase house expenditures exponentially with increasing house prices (Choi, Hong, & Scheinkman, 2014).

4 Life cycle model with housing and house expenditures

In this section a life cycle model with housing and house expenditures incorporated will be derived. A basic four period model is developed. To derive the model, some simplifying assumptions have to be made.

Assumption one: The household lives exactly four periods.

$$t = 1, 2, 3, 4 \tag{1}$$

Assumption two: Lifetime income Y_t is equal to the expected value of lifetime income $E_1 Y_t$. There is no income uncertainty.

$$E_1 Y_t = Y_t \tag{2}$$

Assumption three: The household starts the planned period as a home-owner with an exogenous interest-only mortgage M and intrinsic house value H_1, Net savings and financial assets (mortgage excluded) A are zero in the initial planning period.

$$A_0 = 0 \tag{3}$$

Assumption four: The household has no bequest motive and is not allowed to die indebted.

$$A_4 = 0 \tag{4}$$

Assumption five: The sale of the house is in the beginning of the fourth period, the transfer of the keys is exactly at the end of the last period such that no other house has to be arranged until death.

Assumption six: The intrinsic value of the house depreciates with depreciation rate δ and increases with realized house expenditures $C_{h,t}$. Divestment or negative house expenditures are not possible:

$$C_{h,t} \geq 0$$

$$H_t = H_{t-1}(1-\delta) + C_{h,t-1} \tag{5}$$

Assumption seven: The rate of change in house prices ν is the only source of uncertainty in the model. Furthermore, the expected value of ν is positive and constant.

The market value of the house in period t is as follows:

$$\alpha_t H_t = \alpha_t(H_{t-1}(1-\delta) + C_{h,t-1}) \tag{6}$$

Where $\alpha_t = \alpha_{t-1}(1+\nu)$ is the housing market price level with respect to the intrinsic value. The non-consolidated budget constraints for the four periods can be written as:

$$Y_1 = C_{r,1} + C_{h,1} + A_1 + Mr^M \tag{7}$$

$$A_1(1+r) + Y_2 = C_{r,2} + C_{h,2} + A_2 + Mr^M \tag{8}$$

$$A_2(1+r) + Y_3 = C_{r,3} + C_{h,3} + A_3 + Mr^M \tag{9}$$

$$A_3(1+r)+Y_4+\alpha_4(1-\phi)(H_1(1-\delta)^3+C_{h,1}(1-\delta)^2+C_{h,2}(1-\delta)+C_{h,3}) = C_{r,4}+M(1+r^M) \tag{10}$$

Where $C_{r,t}$ is consumption in period t, r^M is the interest rate paid on the mortgage and ϕ reflects all the transaction costs related to selling the house. This results in the following consolidated budget constraint:

$$\Omega^1 + \frac{E_1(\alpha_4)(1-\phi)}{(1+r)^3}\left(H_1(1-\delta)^3 + \sum_{t=1}^{3} C_{h,t}(1-\delta)^{3-t}\right) =$$

$$\sum_{t=1}^{4} \frac{C_{r,t}}{(1+r)^{t-1}} + \sum_{t=1}^{3} \frac{C_{h,t}}{(1+r)^{t-1}} + \sum_{t=1}^{4} \frac{Mr^M}{(1+r)^{t-1}} + \frac{M}{(1+r)^3} \tag{11}$$

The left hand side is the total amount of money the household expects to receive in their life. Ω^1 is total discounted lifetime income from the perspective of period one. the other term is the total discounted expected return on the sale of the house. The right hand side denotes discounted total lifetime expenditures. These consist of discounted consumption, discounted interest payments and the discounted repayment of the mortgage. The household has the following constant relative risk aversion (CRRA) utility function.

$$U(H_t, C_{r,t}) = \sum_{t=1}^{4} \frac{1}{(1+\rho)^{t-1}} \left(log(C_{r,t}) + \theta log(H_t)\right) \tag{12}$$

Where

$$H_t = H_1(1-\delta)^{t-1} + \sum_{i=1}^{t-1} C_{h,i}(1-\delta)^{t-1-i} \tag{13}$$

The following variables are defined to simplify calculations:

$$\epsilon = E_1(\alpha_4)(1-\phi) \tag{14}$$

$$\kappa = \sum_{t=1}^{4} \frac{Mr^M}{(1+r)^{t-1}} + \frac{M}{(1+r)^3} \tag{15}$$

$$D = 1-\delta \tag{16}$$

$$R = 1+r \tag{17}$$

$$P = \frac{1}{1+\rho} \tag{18}$$

$$S = \frac{\epsilon H_1 D^3}{R^3} \tag{19}$$

Next the effective prices of house expenditures are derived using the discounted depreciated expected return.

$$\pi_1 = 1 - \frac{\epsilon D^2}{R^3} \tag{20}$$

$$\pi_2 = 1 - \frac{\epsilon D}{R^2} \tag{21}$$

$$\pi_3 = 1 - \frac{\epsilon}{R} \tag{22}$$

From (13) and assumption six it follows that:

$$C_{h,1} = H_2 - H_1 D \geq 0 \tag{23}$$

$$C_{h,2} = H_3 - H_2 D \geq 0 \tag{24}$$

$$C_{h,3} = H_4 - H_3 D \geq 0 \tag{25}$$

Using (14) to (25), the consolidated budget constraint (11) can be rewritten as:

$$\Omega^1 + S - \kappa - \sum_{t=1}^{4} \frac{C_{r,t}}{R^{t-1}} - \sum_{t=1}^{3} \pi_t (H_{t+1} - H_t D) = 0 \tag{26}$$

Solving (12) subject to (26) solves the following Lagrangian:

$$\mathcal{L}(H_t, C_{r,t}, \lambda, \mu_t) = \sum_{t=1}^{4} \frac{1}{(1+\rho)^{t-1}} \left(ln(C_{r,t}) + \theta ln(H_t)\right)$$

$$+\lambda \left(\Omega^1 + S - \kappa - \sum_{t=1}^{4} \frac{C_{r,t}}{R^{t-1}} - \sum_{t=1}^{3} \pi_t (H_{t+1} - H_t D) \right) + \sum_{t=1}^{3} \mu_t \left(H_t D - H_{t+1}\right) \tag{27}$$

Where μ_t and λ are the Kuhn-Tucker multipliers. Solving (27) with respect to $C_{r,t}$ and H_t results in the following first order conditions.

$$P^{t-1}\theta H_t^{-1} - \lambda\frac{\pi_{t-1}}{R^{t-2}} + \lambda\pi_t\frac{D}{R^{t-1}} - \mu_{t-1} + \mu_t D = 0 \tag{28}$$

for $t = 2, 3$

$$P^{t-1}\theta H_t^{-1} - \lambda\frac{\pi_{t-1}}{R^{t-2}} - \mu_{t-1} = 0 \tag{29}$$

for $t = 4$

$$P^{t-1}C_{r,t}^{-1} - \lambda\frac{1}{R^{t-1}} = 0 \tag{30}$$

for $t = 1, 2, 3, 4$

4.1 Solution

An additional assumption is needed to ensure the concavity of the Lagrangian (27). This additional assumption is $\epsilon < R$, $\epsilon \geq R$ will be discussed in the subsection "Bubble".

For $\mu_1 = \mu_2 = \mu_3 = 0$:

Solving (28), (29) and (30) gives the following Euler equations

$$\frac{H_2}{C_{r,2}} = \frac{\theta}{R - D} \tag{31}$$

$$\frac{H_3}{C_{r,3}} = \frac{\theta}{R - D} \tag{32}$$

$$\frac{H_4}{C_{r,4}} = \frac{\theta}{\pi_3 R} \tag{33}$$

$$\frac{C_{r,t+1}}{C_{r,t}} = RP \tag{34}$$

And the following closed form solution for $C_{r,1}$

$$C_{r,1} = \frac{\Omega^1 + S - \kappa + \pi_1 H_1 D}{\Lambda_1} \tag{35}$$

where:

$$\Lambda_1 = \sum_{i=0}^{3}(RP)^i + \sum_{i=1}^{2}(\frac{\pi_i}{R^{i-1}}\frac{\theta(RP)^i}{R-D}) - \sum_{i=1}^{2}(\frac{\pi_{i+1}}{R^i}\frac{\theta D(RP)^i}{R-D}) + \frac{\theta(RP)^3}{R^3} \tag{36}$$

and

$$\frac{C_{r,1}\theta RP}{R-D} \geq H_1 D \tag{37}$$

$$\frac{RP}{R-D} \geq \frac{D}{R-D} \tag{38}$$

$$\frac{P}{\pi_3} \geq \frac{D}{R-D} \tag{39}$$

For $\mu_1 > 0, \mu_2 = 0, \mu_3 = 0$:

If (37) does not hold, it must be that $\mu_1 > 0$, then the solution is as follows if $\mu_2 = \mu_3 = 0$ is assumed:

$$C_{r,1} = \frac{\Omega^1 + S - \kappa + \frac{\pi_2 H_1 D^2}{R}}{\Lambda_2} \tag{40}$$

$$\Lambda_2 = \sum_{i=0}^{3}(RP)^i + \frac{\pi_2}{R}\frac{\theta(RP)^2}{R-D} + \frac{\theta(RP)^3}{R^3} - \frac{\pi_3}{R^2}\frac{\theta D(RP)^2}{R-D} \tag{41}$$

$$\frac{C_{r,1}\theta(RP)^2}{R-D} \geq H_1 D^2 \tag{42}$$

$$\frac{P}{\pi_3} \geq \frac{D}{R-D} \tag{43}$$

For $\mu_1 > 0, \mu_2 > 0, \mu_3 = 0$:

If (42) does not hold, it must be that $\mu_2 > 0$, then the solution is as follows if $\mu_3 = 0$ is assumed:

$$C_{r,1} = \frac{\Omega^1 + S - \kappa + \frac{\pi_3 H_1 D^3}{R^2}}{\Lambda_3} \tag{44}$$

$$\Lambda_3 = \sum_{i=0}^{3}(RP)^i + \frac{\theta(RP)^3}{R^3} \tag{45}$$

$$\frac{\theta(RP)^3 C_{r,1}}{\pi_3 R} \geq H_1 D^3 \tag{46}$$

For $\mu_1, \mu_2, \mu_3 > 0$:

In the case that (37), (42) and (46) do not hold there are no house expenditures in all periods. The solution is very similar to the model without house expenditures as derived by Suari Andreu (2014)

$$H_4 = H_3 D = H_2 D^2 = H1D^3 \tag{47}$$

$$C_{r,1} = \frac{\Omega^1 + S - \kappa}{\sum_{i=0}^{3}(RP)^i} \tag{48}$$

4.2 Realistic case

As showed by Choi et al (2014), houses are rarely traded above their intrinsic value[1]. It is therefore safe to assume that most of the time $\epsilon < R$ holds.

with house expenses

For (37), (42) or (46) to hold it must be that H_1 is sufficiently low. These conditions indicate whether the exogenously given H_1 is sufficiently low to justify house expenses in order to maintain or improve the intrinsic house value. Since most households will have bought the house in $t < 1$ themselves it is likely that the value is optimal such that:

$$\frac{C_{r,1}\theta}{(R-D)H_1} > 1 \tag{49}$$

Moreover, it is very likely that $RP > D$ as most households will experience relatively small differences between interest rates and time preference [2]. The difference will probably not be

[1] In this papers definitions of intrinsic value, house expenditures increase intrinsic value with the expenditure. These are rarely profitable, it must be that houses are traded below intrinsic value.

[2] Large differences would imply that households would be willing to sacrifice a lager share of current consumption for future consumption or otherwise.

as high as the housing depreciation rate. So it is safe to assume that under stable economic conditions (37) and (38) will hold for most of the households. From a realistic point of view it is uncertain if (39) holds. It is safe to assume that normally $P > 0.9, D > 0.9, R < 1.1$ so for (39) to hold it must be that $\pi_3 = 1 - \frac{\epsilon}{R} < 0.2 \iff E_1\alpha_4(1-\phi) > 0.72$ which is not unrealistic.

without house expenses

In some cases, a household owns a house which has above optimal intrinsic value. This might be the result of a large negative lifetime income shock or because it acquired the house without control as a (partial) gift of inheritance. Then (37), (42) or (46) will only hold when $RP > D$ is sufficiently large. The household will not be willing to maintain or improve the house until depreciation naturally lowers the house value to an optimal level.

4.3 Bubble

When the assumption $\epsilon < R$ does not hold, the objective function loses its concavity. Any increase in $C_{h,3}$ will be utility increasing and budget increasing or budget neutral. Maximizing utility will result in maximizing $C_{h,3}$. Since no liquidity constraints are imposed in this model, there are no solutions. These liquidity constraints could be included but would be arbitrarily chosen as they rely on a large number of continuously changing conditions.

As ϵ increases, these conditions would loosen until ϵ is significantly larger than $1+r$. This would eventually result in the elimination of any liquidity constraints on $C_{h,3}$. Any investor will be willing to supply liquidity for house improvements and maintenance expecting a higher interest r^L on this one period loan as long as $1 + r < r^L < \epsilon$. House expenditures and house values would soar and this would inflate a housing bubble. This behaviour only applies to $C_{h,3}$ because depreciation in earlier periods leads to lost potential profits on any house expenditure before the third period. As house expenditures in period one and two have an opportunity cost compared to the third period, households will behave as in the non-bubble situation.

This will hold until expected prices start falling [3] such that $\epsilon \geq 1 + r$ does not hold any more. Because households will lower their expectations on the after sale return of the house, they will experience a negative lifetime income shock and defer house expenditures until house value has decreased to optimal. This optimal housing value is lower than before the bubble. The households have spend a larger share of lifetime income to maintenance and improvements in the bubble resulting in below optimal net savings.

The loosening effect of house price increases on liquidity constraints is confirmed by Artle and Varaiya (1978). A substantial decrease in house expenditures following a price decline from above to below intrinsic value is confirmed by Gyourko and Saiz (2004). For the recent financial crisis this is confirmed by data from the Joint Centre for Housing Studies (JCHS) (2009). They report a strong increase in remodelling expenditures before the crisis in 2008, and a strong decrease in and after the crisis. The JCHS reports that these changes are related to changing credit conditions and lower shares of return on the improvements. The magnitude of the effect in and after the crisis is strongly related to the regional house price appreciation in the periods preceding the crisis.

4.4 Changing expectations

Since S is increasing in ϵ and π_1, π_2, π_3 are all decreasing in ϵ. This results in:

$$\frac{\partial C_{r,1}}{\partial \pi_1} \leq 0 \tag{50}$$

$$\frac{\partial C_{r,1}}{\partial \epsilon} > 0 \tag{51}$$

[3] An increasing number of households will start selling their house to monetize their gains and demand will eventually dry up as households buying their first house loose purchasing power because they do not profit from the bubble.

In all situations. When (37), (42) or (46) holds:

$$\frac{\partial}{\partial \epsilon}\frac{\partial C_{r,1}}{\partial \epsilon} > 0 \tag{52}$$

Any increase in the expected price level will result in higher consumption in all periods and higher house expenditures in at least one period. This effect of an increase in expected price level increases with the price level. Decreasing expected prices result in lower house expenditures and lower consumption.

When (37), (42) and (46) do not hold, a small increase in the expected price level will increase consumption only through the higher selling value of H_1. When the increase in expected price level causes (46), (42) or (37) to hold (in order of likelihood), any additional price increase will increase consumption and house expenditures exponentially.

When the housing market is in a bubble situation any increase in expected price level increases return for investors (banks). They will be willing to take higher risks by supporting inferior projects and higher risk households such that:

$$\frac{\partial C_{h,3}}{\partial \epsilon} > 0 \rightarrow \frac{\partial H_4}{\partial \epsilon} > 0 \rightarrow \frac{\partial C_{r,1}}{\partial \epsilon} > 0 \tag{53}$$

The liquidity constraints will be eased by increasing expected prices up until the point that high expected prices compensate for all risk related constraints. At this point, investors will supply credit with the investment as collateral without substantial down-payments or income conditions. This is what happened in the years before the 2008 financial crisis (Joint Center for Housing Studies, 2009).

For declines in the expected price level, the opposite of the above mentioned dynamics will occur. The dynamics will converge to the linear model where house expenditures are minimized. The effect of changing house prices through house expenditures will fall. If the expected house price level falls from $\epsilon > R$ to $\epsilon < R$, households will stop expecting profits on maintenance and improvements and a major negative shock in house expenditures will occur as observed by Gyourko and Saiz (2004).

4.5 Saving

The relation of expected price level with saving can be derived from (8) and (9):

$$A_t = A_{t-1}(1+r) + Y_t - C_{h,t} - C_{r,t} - Mr^M \tag{54}$$

where $C_{h,t}$ is a linear function of $C_{r,t}$ as can be derived from (23), (31) and (34) and where $C_{r,t}$ increases exponentially with the expected price level ϵ. The following relation with changing expectations can be derived:

$$\frac{\partial A_t}{\partial \epsilon} < 0 \tag{55}$$

$$\frac{\partial}{\partial \epsilon}\frac{\partial A_t}{\partial \epsilon} < 0 \tag{56}$$

5 Methodology & Econometric model

The model hypothesises a set of dynamics that is discussed in the previous section. These dynamics can be tested empirically. Before the econometric models are defined, a proxy has to be determined for the expected price level. The expected price level at time of sale as expected by households is not available in the data. In the absence of better information, it is necessary to assume that households consider expected price levels as a function of a known price level. Using assumption seven the relationship with the price level can be described as follows:

$$\epsilon = \alpha_{t-1}(1 + E_{t-1}v_t)(1+v)^T(1-\phi) \tag{57}$$

Where T is the unknown year of sale. Last year in $t = t-1$, $E_{t-1}v_t = v$ by assumption seven. In the current year the real v_t is known. Any deviation in v_t from the expectation $E_{t-1}v$ will have a direct permanent effect on the expected price level at time of sale. This surprise in the price level growth will be used as an observable proxy for changing price expectations of households. This is the same measure that Suari Andreu (2014) uses. The base price level - $\alpha_{t-1}(1 + E_{t-1}v_t)$ - will be used as a proxy for the price level itself. The use of this year's price level as expected last year instead of the observed price level this year has one main reason. There is assumed that households have constant expectations of v. However, it is very likely that this constant v differs among households. The usage of $\alpha_{t-1}(1 + E_{t-1}v_t)$ allows for some flexibility with respect to the optimism of households.

The model predicts that with stable lifetime income, expected housing price level and preferences households smooth consumption and housing value. Consumption increases or decreases in time depending on discount rates and time preference. Housing expenditures depend on the discount rates and time preference compared to the depreciation rate of the house. Housing expenditures will be a fixed share of the house value under stable conditions and the house value will smoothly increase, decrease or remain unchanged.

Following a positive surprise in the price level growth, the model predicts exponentially increasing consumption and optimal housing value. This will inflate house expenditures such that the optimal housing value is reached as fast as possible. Optimal saving will fall increasingly faster as the house price level increases. Dissaving or borrowing to fund higher consumption and house expenditures may be the result.

Following a negative surprise in the price level growth, the model predicts the opposite behaviour as with a price increase. The effects on house expenditures are however limited by the impossibility to engage in negative house expenditures. After a large negative shock, house expenditures will fall to zero and it might take more than one period to arrive at the optimal house value. Optimal saving will increase as a result of lower optimal consumption and lower optimal house expenditures. These effects will be stronger at higher price levels and the probability of zero house expenditures being optimal after a negative shock rises with the expected price level.

The interaction of the surprise in the price level with the current year's price level as expected last year is used in the econometric models. The use of the interaction allows for sensitivity to price levels as expected by the theoretical model.

The dynamics mentioned above will be examined using two econometric models.

$$\triangle S_{i,t} = \beta_0 + \beta_1 u_{i,t} + \beta_2 u_{i,t} e_{i,t} + X_{1,i,t}\omega + X_{2,i,t}\phi + c_i + \epsilon_{i,t} \tag{58}$$

$$Ch_{i,t} = \beta_3 + \beta_4 u_{i,t} + \beta_5 u_{i,t} e_{i,t} + X_{1,i,t}\omega + X_{2,i,t}\phi + c_i + \epsilon_{i,t} \tag{59}$$

Where $\triangle S_{i,t} = S_{i,t} - S_{i,t-1}$ is the change in savings. $Ch_{i,t}$ are the house expenditures by household i in year t. $u_{i,t}$ is the surprise in price level in year t. $e_{i,t}$ is the expected price level for the current year as expected one year in the past. All βs are unknown coefficients that are being estimated including a constant. β_1 is expected to be positive where β_2 is expected to be negative. That would indicate a with the price level increasing effect as predicted by the model. β_4 is expected to be negative and β_5 positive to show the increasing effect.The price levels will be considered with respect to the province level prices and to the national price level. $X_{1,i,t}$ is a row vector with all relevant available economic variables: Net income in year t, interest income, residual mortgage debt, yearly mortgage expenditure, House value, and the possession of a national mortgage guarantee. This national mortgage guarantee is an insurance scheme that the household is able to join when the house is bought. It ensures the households mortgage payments under circumstances that have changed beyond control such as divorce, unemployment, illness and more. It is likely that this will lower the need for precautionary savings. $X_{2,i,t}$ is a row vector containing relevant demographic variables namely: Age, higher education[4] completed(dummy) , number of children, partner(dummy) and self-reported risk aversion. ω and ϕ are vectors with the corresponding unknown coefficients. c_i represents the unobserved indi-

[4]University and university of applied sciences (HBO).

vidual household effect. $\epsilon_{i,t}$ is the independent error term.The model for house expenditures is derived from (31), (34), (35) and (36) where I have used (50), (51) and (52) to simplify the relations with the expected future price level. Due to the presence of the individual household effect and the potential correlation of it with the explanatory variables, Mundlak panel data estimators as explained by Wooldridge (2010) are employed for all estimations (Mundlak, 1978). That is a widely used method in panel data estimations. To deal with the categorical saving response data, I utilise interval regression techniques. Three types of regressions will be estimated.

First, for the dynamics of saving (58), interval regressions with Mundlak terms are estimated. These will be similar to Suari Andreu(2004) with the same econometric technique and the same control variables except economic growth. To see whether the use of the interaction term and the flexibility to price level improves the performance of the model, all regressions are repeated with the interaction term.

Second, for the effect of unexpected house price changes on house expenditures (59), Tobit estimations with Mundlank terms will be employed. This is necessary to deal with the non-negativity of house expenditures.

Third, the interval estimation (58) for saving with Mundlak terms will be repeated allowing for asymmetric effects.

Because all analyses are conducted using national and province price levels, the use of year dummies is ill-advised. Suari Andreu(2004) uses national GDP growth numbers to capture omitted business cycle effects. This is problematic as these are highly correlated with unexpected house price changes. The largest effect of the business cycle on households will be through wages which are included in household income and controlled for. Another potential mechanism by which economic growth affects households is by increasing housing values. Since this is the effect of interest in this thesis, including economic growth would disturb the results. Passive capital gains as a result of economic growth, as argued by Engelhardt(1996), are not worrisome since the saving measure used here is self-reported active saving.

6 Data

To estimate (58) and (59), the dataset from the Dutch national bank Household Survey (DHS) is used. It includes panel data information on a number of topics such as income, housing, wealth, demographics and more. This survey contains self-reported data between 1993 and 2017 for approximately 2000 households. A description of all used variables is showed in table A1. Respondents report if and how much the household has dissaved/saved in seven categories; less than 1.500, between 1.500 and 5.000, between 5.000 and 12.500, between 12.500 and 20.000, between 20.000 and 37.500, between 37.500 and 75.000 or more than 75.000. In table A2 saving is showed using the midpoints of these categories. Since 2004[5], questions regarding house price expectations are included. The respondents are asked whether they expect house market prices to increase or decline in the following 2 years and the expected yearly percentage. Added in the survey of 2012, the respondents report how much they spend on house maintenance improvements. Although very limited data is available, this allows for a direct analysis of house expenditures.The recording of the data is throughout the entire year.

To prevent duplicate and potential inaccurate data, only respondents who identify as the head of the household are considered. Furthermore, For households reporting that they have moved, only the longest period without moving is included.

House price index data is available at the province and national level as measured and published by Statistics Netherlands (CBS). Suari Andreu (2014) showed that households mainly respond to these observations. They are published in all relevant newspapers and mentioned in a large number of TV-shows. The CBS data is calculated using all house transactions in the Netherlands during the year of interest. The publication date is approximately one month

[5] Although mentioned on their website since 2003, it is only available in the data since 2004.

after the year has ended. As the data for 2017 is not yet made available, the price index and price index growth for the third quarter of 2017 is extrapolated. In the appendix, in table A1, a definition of all variables is given. In table A2, summary statistics of all the variables are presented. In Figure A1, the national house price development over the years is shown. In Figure A2, the average surprise in house price growth is shown. Figure A3 shows the average house expenditure.

7 Results

In all tables S.PR is the surprise at province lever where S.NL is the surprise in the national price level. E.PR is the expected province price level and E.NL is the expected national level. In table 1, the results of the interval regression with Mundlak terms are shown similar to the results of Suari Andreu (2014). In columns one and three, a negative effect of a surprise on saving can be seen both with province and national data. Although similar, the effect is only statistically significant for the national price change. Columns two and four show estimations that include both the surprise and the interaction of the surprise with the expected price level. This improves the flexibility of the model with respect to the expected price level. The results are promising as they show that the magnitude of the effect is strongly influenced by the price level. The interaction effect with the price level is statistically significant and shows a negative effect of unexpected price changes on saving that is increasing with the price level. When the price index is 0.9, a surprise of 0.01 in the price level would decrease saving with €18.64. When the price index is 1, the same increase would decrease saving with €44.47.

In table 2, the results of the Tobit regression with Mundlak terms on house expenditures are presented. No statistically significant results can be found in columns one to four. The estimated coefficients are of the unexpected sign. Moreover, despite the insignificance, the magnitude of the coefficients signal that this might not be the result of a limited sample size.

Table 1: Saving: Interval regression with Mundlak terms

	(1)	(2)	(3)	(4)
S.PR x E.PR		-20,459		
		(14426)		
S.PR	-2,620	16,739		
	(1,777)	(13,654)		
S.NL x E.NL				-25,830*
				(13,887)
S.NL			-3,033*	21,383
			(1,759)	(13,198)
Control variables	Yes	Yes	Yes	Yes
Observations	4,873	4,873	4,898	4,898
Households	1,229	1,229	1,236	1,236

Household clustered standard errors in parentheses. Dependent variable is reported household saving. The control variables are: Income, house value, mortgage debt, mortgage expenditures, age2, age3, university, no. of children, partner, risk aversion and NMG. Mundlak terms / time averages are included for all variables except NMG, age2, age3, University and partner. *** signicant at the 1% level, ** signicant at the 5% level, * signicant at the 10% level.

An additional estimation is shown in column 5. The exclusion of control variables doubles the number of observations. Even though the estimated coefficient is doubtlessly biased, the sign and magnitude are in line with the coefficients from estimations (1) and (3). Repeating the estimation with any combination of the control variables does not change the sign nor does it affect the magnitude substantially. Fortunately, this observation does not contradict the model. The house expenditure responses are only available since 2012. As can be seen in Figure A1, this was the fourth consecutive year of strong price declines. In the Netherlands it is common to finance the purchase of a house completely with a mortgage. In the years preceding the housing crisis, it was possible to acquire a mortgage with a value higher than the house. Mortgages 120 percent of house value were even available. Selling the house after strong price declines would result in large mortgage debt. This foresight of debt may have refrained households willing to move from doing so. Households in need of more living space may have felt they had no other option than to remodel or improve their currently owned house. When house prices started to increase in 2013, some households potentially repaid a substantial share of their mortgage. It could be that households felt the urge to move before the price of the desired house starts increasing. This could be an explanation of the decrease in house expenditures.

A number of previous studies have shown asymmetric house price effects on saving and consumption while others fail to find these asymmetries. In table 3, estimation results for saving are shown when asymmetry is allowed. Substantial differences in the size of the effect arise. Nonetheless, the signs are unaffected. The differences in size show asymmetry in line with the conclusions of Engelhardt(1996) and Suari Andreu(2004). Suari Andreu (2004) is only able to show this asymmetry using observed price changes. Here additional evidence is found for the asymmetry of the wealth effect using reported unexpected changes.

A striking difference with the results from Suari Andreu (2004) is the estimated magnitude of the effect. The estimated effects are approximately half the size of the effects as estimated

Table 2: House expenditures: Tobit regression with Mundlak terms

	(1)	(2)	(3)	(4)	(5)
S.PR x E.PR		-20,153			
		(35,879)			
S.PR	-2,576	16,028			-4,213 **
	(3,081)	(33,931)			(2,119)
S.NL x E.NL				-32,121	
				(39,645)	
S.NL			-2,357	27,417	
			(2,963)	(37,361)	
Control	Yes	Yes	Yes	Yes	No
Observations	2,427	2,427	2,445	2,442	4,847
Households	815	815	822	822	1,439

Household clustered standard errors in parentheses. Dependent variable is reported house expenditures. The control variables are: Income, house value, mortgage debt, mortgage expenditures, age2, age3, university, no. of children, partner, risk aversion and NMG. Mundlak terms / time averages are included for all variables except NMG, age2, age3, University and partner. *** signicant at the 1% level, ** signicant at the 5% level, * signicant at the 10% level.

Table 3: Saving: Asymmetric interval regression with Mundlak terms

	(1)	(2)	(3)	(4)
S.PR x E.PR		-9,732		
		(24,302)		
S.PR x E.PR x neg		-33,113		
		(45,460)		
S.PR	-1,352	6,427		
	(2,987)	(20,733)		
S.PR x neg	-2,378	33,626		
	(4,470)	(45,000)		
S.NL x E.NL				-26,472
				(27,157)
S.NL x E.NL x neg				-11,079
				(45,364)
S.NL			-1,328	20,657
			(3,067)	(23,065)
S.NL x neg			-3,165	13,539
			(4,383)	(44,879)
Control variables	Yes	Yes	Yes	Yes
Observations	4,873	4,873	4,898	4,898
Households	1,229	1,229	1,236	1,236

Household clustered standard errors in parentheses. Dependent variable is reported household saving. The control variables are: Income, house value, mortgage debt, mortgage expenditures, age2, age3, university, no. of children, partner, risk aversion and NMG. Mundlak terms / time averages are included for all variables except NMG, age2, age3, University and partner. *** signicant at the 1% level, ** signicant at the 5% level, * signicant at the 10% level.

by Suari Andreu (2004). This is the result of the inclusion of the years 2014 to 2017. This difference in magnitude is only partially explained by the asymmetry in the results in table 3. As can be seen in figure A2, Unexpected changes have been very high in the years 2014 to 2017. Households experiencing positive surprises may have become more pessimistic and prudent and the willingness to consume out of housing wealth might be lower than before the financial crisis. Households still experiencing negative surprises in 2014 or later may have lowered their sensitivity to these surprises after six or more consecutive years of declining prices.

8 Conclusion

House expenditures are an important part of the economy and an indispensable factor in explaining household behaviour, consumption and saving. The inclusion of house expenditures in the life cycle model with housing shows that these house expenditures magnify the effect of fluctuating house prices on consumption and saving. In this paper this extended life cycle model is developed and the dynamics that the model predicts are tested empirically. The expected effect of house price changes on active saving is found in an extension of the model, analysis and results of Suari Andreu(2014). This size of the effect is increasing with the price level as predicted by the extended model.

The responses from the recently added question in the Dutch National Bank Household survey are utilised. These questions ask about house expenditures. Unexpected effects of house price surprises on house expenditures are found. Fortunately, this does not mean that the model and its predictions should be rejected. The question was added to the survey in 2012. That was the first year after one of the largest national house price declines in modern history. This introduces extraordinary behaviour beyond the scope of this thesis. Previous studies using larger datasets and more extensive models found strong evidence for a strong positive convex relation between house expenditures and the price level. More research into the Dutch case should be done when more data is available.

I find evidence for some asymmetry in the effect on saving. In contrast to Suari Andreu (2014), the effect following a positive surprise is not completely eliminated. This might be the result of the inclusion of the years 2014 to 2017 in the analysis. Although prices were strongly increasing, for most households this increase was not so much a boom but a recovery. The recovery may have induced consumption that was postponed during the crisis. The differences in magnitude with the results from Suari Andreu (2014) are not completely explained when there is accounted for the asymmetry in the effect. This difference is also the result of the inclusion of the years 2014 to 2017. These years showed strong price increases. Despite consecutive years of strong growth, expectations stayed low and large positive surprises are seen in 2014 to 2017. Households may have adjusted both their expectation mechanism as their response to surprises to more prudent behaviour after the financial crisis.

Extending a life cycle model of consumption and saving with house expenditures is a logical step. The presence of literature that strongly confirms the relation of house expenditures and house prices supports this model. The insights the model provides are useful tools in the design of policy. Nonetheless, more studies are necessary to improve and confirm the predictions of the model. That is challenging, while long-term continuing data collection should provide new insights, trends in behaviour seem to change very fast. Collective household behaviour responds to large financial events such as the financial crisis and this complicates empirical analyses substantially.

9 Policy Implications and Recommendations

The presence of the effect of house price changes on house expenditures and saving has widespread implications for government policy. In the years after the crisis of 2008 following large declines in housing prices and large declines in construction, maintenance and improvement expenditures, the Dutch government temporary lowered taxes on these expenditures. This lowered effective costs and was meant to support struggling entrepreneurs in these sectors. The intended effects were two-sided. First, the lowered taxes would increase net income for entrepreneurs. Second, the lowered relative cost of house expenditures compared to other consumption and future house expenditures was meant to shift funds from consumption and savings towards house expenditures.

The inclusion of house expenditures in the life cycle model shows that this measure has unintended positive side effects on all expenditures and a stronger effect on saving. Besides the intended effect, the lowered effective price of house expenditures increases real lifetime income. This increases consumption and optimal housing value. This higher optimal housing value induces high house expenditures in the first year and slightly higher house expenditures in the future. Unlike future maintenance brought forward, these increased expenditures are not compensated by lower expenditures in the future. The policy is more effective than intended and has positive side effects on consumption.

When house price levels are increasing, the measure could be reversed. First, taxes would return to normal. After a period of large price increases, taxes could be increased or even coupled to price levels. This should be aimed at keeping effective prices positive. This would be a so-called counter-cyclical measure. It will prevent households from spending irresponsibly large amounts on improvements in housing bubbles. In the price increasing phase this will restrain bubble formation. When the bubble bursts, negative lifetime income shocks will be smaller as a result of lower intrinsic house value. Moreover, it prevents value destruction that occurs when households invest large amounts of money in improvements during the bubble that languish after the burst.

To conclude, the effects of changing house prices on house expenditures magnify the effect of house price changes on consumption and saving at higher price levels. This expands the preexisting set of arguments in favour of house price stability in a world where housing bubbles and bursts occur commonly.

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In this thesis use is made of data of the DNB Household Survey administered by CentERdata (Tilburg University, The Netherlands).

Appendix: Additional Tables and figures

Table A1: Definitions of variables

Variable	Definition	Source
Saving	Reported household saving. Money put aside in Euros in the past 12 months.	DHS
House Expenditure	Reported expenditures on maintenance and improvements in Euros.	DHS
Income	Total reported net income of the household	DHS
House value	Value of the house in thousand Euros if the house were to be sold	DHS
Mortgage debt	Mortgage debt in thousand Euros, sum of mortgage debt is the households has more than one mortgage.	DHS
Mortgage expenditures	Total mortgage expenditures in euros, sum of mortgage expenditures if there are multiple mortgages.	DHS
Age	Age of the respondent (head of the household).	DHS
Age1, Age2, Age3	Dummies indicating if the age is below 35, between 35 and 65 or above 65.	DHS
University	Dummy indicating university education, including university of applied sciences (HBO).	DHS
No. of Children	Number of children in the household.	DHS
Partner	Dummy indicating whether there is a partner in the household	DHS
Risk aversion	Risk aversion parameter, constructed based on 6 questions related to investment and saving decisions.	DHS
NMG	Dummy indicating if the household has the national mortgage guarantee insurance.	DHS
HPI-PR	House price index (2010 = 1) at the province level.	CBS
HPI-NL	House price index (2010 = 1) at the national level.	CBS
gHPI-PR	Year on year growth rate in HPI-PR.	CBS
gHPI-NL	Year on year growth rate in HPI-NL.	CBS
gExpected	Yearly growth rate in house prices in the next two years as expected by the head of the household.	DHS
EPI-PR	Expected price index, calculated using last years expectation and HPI-PR	DHS, CBS
EPI-NL	Expected price index, calculated using last years expectation and HPI-NL	DHS, CBS
Surprise-PR	gHPI-PR minus gExpected	DHS, CBS
Surprise-NL	gHPI-NL minus gExpected	DHS, CBS

DHS is the Dutch national bank Household Survey, CBS is the dutch acronym for Statistics Netherlands.

Table A2: Summary statistics

VARIABLES	(1) No of obs	(2) Mean	(3) Std. dev.	(4) min.	(5) max.
Saving (category midpoints)	12,498	6,127.9	8,183.634	-37,500	75,000
House expenditures	6,275	4,175.6	13,551.6	0	500,000
Income	12,665	41475.37	0.0787	5,000	75,000
House value	13,473	273.2	153.0	0	5,500
Mortgage debt	12,540	92.852	105.368	0	1,100
Mortgage expenditures	12,452	4,888.2	5,239.1	0	74,400
Age	14,656	55.15	14.65	23	93
Age1	14,656	0.0963			
Age2	14,656	0.603			
Age3	14,656	0.301			
University	14,656	0.479			
No. of Children	14,656	0.681	1.067	0	7
Partner	14,656	0.766			
Risk aversion	12,508	0.670	0.155	0.0714	3.571
NMG	9,858	0.350			
HPI-PR	14,586	0.947	0.0703	0.814	1.132
HPI-NL	14,656	0.9472	0.06437	0.853	1.059
gHPI-PR	14,586	0.0120	0.0437	-0.0731	0.106
gHPI-NL	14,656	0.0128	0.0428	-0.0657	0.0760
gExpected	12,724	0.00327	0.0413	-0.25	0.25
EPI-PR	10,049	0.951	0.0787	0.6672	1.2925
EPI-NL	10,094	0.951	0.0745	0.6824	1.285
Surprise-PR	10,049	0.00503	0.0544	-0.230	0.257
Surprise-NL	10,094	0.00620	0.0538	-0.222	0.276

Only the data from the head of the households is used. Only households owning a house are considered. Saving and income are recorded in intervals. Here the midpoints are shown.

Figure A1: National House Price Index

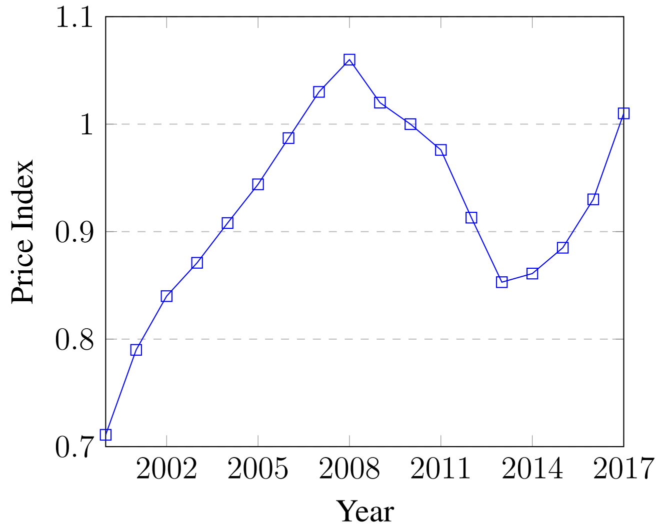

Figure A2: Average Surprise

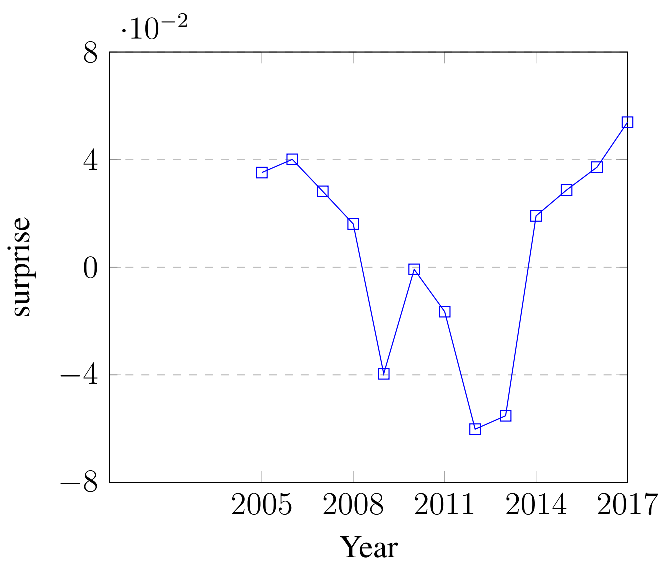

Figure A3: Average House Expenditure